Effect of Temperature on Egg Capsule Deposition in the Mud Snail, *Nassarius obsoletus* (Say)

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(2 Text figures)

INTRODUCTION

Temperature, food and light affect the reproductive activity of marine invertebrates (Barnes, 1963; Loosanoff & Davis, 1952; Sastry, 1963, 1966, 1968). It has been suggested that the pattern of annual reproductive activity for a species may be a genetically controlled response to the environment and that variation in geographically separated populations can either be induced as the phenotypic response of a single genotype or else be truly genetic (Sastry, 1970).

The mud snail, *Nassarius obsoletus* (Say, 1822) has a wide geographical distribution ranging from the Gulf of St. Lawrence to northern Florida on the east coast of North America, resulting in many geographically separated populations exposed to different temperatures (Abbott, 1954; Schroeder, 1966). The period of egg capsule deposition varies among the separate populations (Jenner, 1956). The present study examines the reproductive activity of *Nassarius* throughout the year and the effect of various temperatures on the deposition of egg capsules.

MATERIALS and METHODS

The snails were collected at monthly intervals on a sand-mud flat in the vicinity of the Duke University Marine Laboratory, Beaufort, North Carolina. The reproductive condition of the monthly samples was determined by microscopic examination of the gonadal tissue. Only adult females (14.5 - 25.0 mm) and males (15.0 - 21.1 mm) were examined. The gonads were classified as developing, mature or neutral. Developing gonads were those with spermatocytes and spermatids or oocytes.

During October, December and January, a large number of snails was collected and females exposed without food to 10°, 15°, 20°, 25° and 30° C in the laboratory. The photoperiod was set for 12 hours of light and 12 hours of darkness. The time from collection until deposition of egg capsules was recorded for each temperature group.

OBSERVATIONS

Reproductive Cycle

Males: Spermatozoa were observed from January through May. The gonads were neutral from June to the end of September. The copulatory organ was reduced to a short papilla but regenerated with the onset of spermatogenesis. Jenner & Chamberlin (1956) found good correlation between the reduction of copulatory organ and the cessation of seasonal reproductive activity. Spermatogonia and spermatocytes appeared in October. During November and December spermatozoa were observed as well. With the development of spermatozoa, the gonads turned from their neutral brown to purple.

Females: The reproductive condition of females in the monthly samples is shown in Figure 1. Oocytes in the vitellogenesis growth phase and a few eggs were observed in January. Mature eggs were predominant from February through May. During this period the animals shed the eggs freely when they were removed from their shells. The gonads were neutral from June through September. Oogenesis began in October, with the oocytes entering cytoplasmic growth phase during November and the vitellogenesis growth phase in December. The gonads, brown in the neutral condition, became cream white on maturity.

Egg capsule deposition: In the field there were large numbers of egg capsules between the end of February

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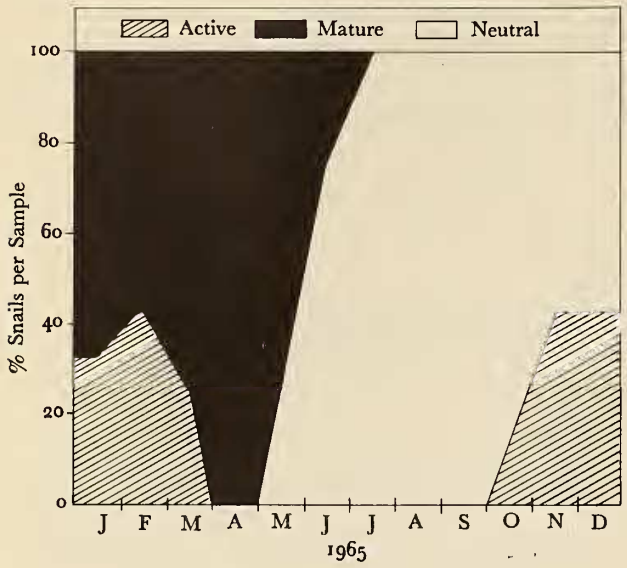

Figure 1

The gonad condition of *Nassarius obsoletus* females in the monthly samples

and May. A few egg capsules, however, appeared as early as late December, when the water temperatures were slightly higher than normal. During the winter the snails usually burrowed into the substratum or aggregated in shallow tide pools where the water was slightly warmer than below the tide mark. The colder temperatures in the winter may have been responsible for the delay in deposition of egg capsules until February, since the animals were already in a mature state by the end of December.

Effect of Temperature on the Deposition of Egg Capsules

Snails collected in October did not deposit egg capsules at any of the experimental temperatures in the laboratory. Snails collected in December deposited the egg capsules, but only at intermediate temperatures. No egg capsules were deposited at the extremes of 10° and 30° C. Snails collected in January deposited egg capsules at all the experimental temperatures. The time required for deposition of eggs shows a direct correlation with temperature (Figure 2). It also appears that the time required for the deposition of egg capsules decreases the closer the population is to the time of deposition in the natural habitat. From February through May, snails brought to the laboratory deposited their egg capsules readily.

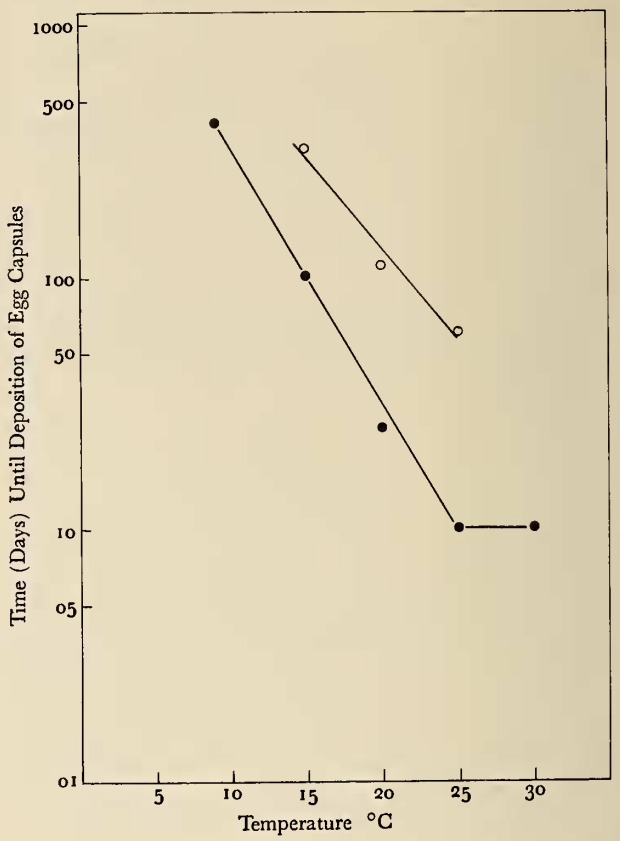

Figure 2

Days until deposition of egg capsules for snails maintained at different temperatures

○——○ December collection ●——● January collection

DISCUSSION

In the annual reproductive cycle of *Nassarius obsoletus*, deposition of egg capsules occurs from the end of February through May at Beaufort, North Carolina. A neutral period in the summer is followed by gametogenesis in the fall. Although the population developes mature gametes by the end of fall, the deposition of egg capsules is delayed until late February. This delay in deposition may be due to low winter temperatures. Egg capsules seem to be deposited in winter when the temperature is slightly warmer than usual. Apparently, there is a minimum temperature which must be exceeded before the deposition of egg capsules can begin.

The egg capsules are deposited within a range of temperatures. Within this range, the time required for deposition seems to correlate with the temperature to

which the snails have been exposed. Deposition seems to occur, however, only after the oocytes have reached the vitellogenesis growth phase. Sastry (1966) reported that in the bay scallop, *Aequipecten irradians* (Lamarck, 1819) the time required for oocyte growth to maturation and spawning was directly influenced by the temperature to which the scallops had been exposed. It was also reported (Sastry, 1968) that oocyte growth began when the environmental temperatures exceeded a certain minimum and food was available.

Scheltema (1967) reported that gametogenesis in geographically separated populations of *Nassarius* from Cape Cod, Massachusetts, and Beaufort, North Carolina, is completed by the end of fall but that the period of egg capsule deposition and the neutral period are different. The variation in the period of egg capsule deposition for populations between Booth Bay Harbor, Maine and Mayport, Florida is reported to correlate with the temperature distribution along the Atlantic Coast (Jenner, 1956). It appears that the population differences in the period of egg capsule deposition and neutral period are related to the time when the required environmental temperature is reached in different parts of the range. Variation in reproductive activity, therefore, appears to be environmentally induced response within the genetic limits of this species.

SUMMARY

1. In the annual reproductive cycle of *Nassarius obsoletus* at Beaufort, North Carolina, the period of egg capsule deposition occurs from the end of February through May.

2. The time until deposition seems to be regulated by the water temperature.

3. The variation in geographically separated populations appears to be influenced by the time when the required temperatures for gametogenesis, egg capsule deposition and neutral period develop in different locations. Hence, the variation in geographically separated populations probably reflects environmentally induced reponse of the same genotype.

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